U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

6.1.2 PROTECTIVE COATING SYSTEMS (PAINTS) - ORGANIC MATERIALS

REVIEW RESPONSIBILITIES

Primary - Materials and Chemical Engineering Branch (~~CMEB~~ EMCB[1])

Secondary - None

I. AREAS OF REVIEW

1. The protective coating systems (paints) used inside the containment are evaluated as to suitability for design basis accident (DBA) conditions.

2. The stability of materials including protective coatings and organics are examined to determine the potential formation of decomposition products under DBA conditions. Radiation and chemical effects are considered.

Review Interfaces[2]

The ~~Accident Evaluation Branch (AEB)~~EMCB[3] as part of its primary review responsibility for SRP Section 6.5.2 also[4] reviews the fission product removal effectiveness of the containment protective coating systems as well as the containment spray system.

In addition, the ~~CMEB~~ EMCB[5] will coordinate other branches[6] evaluations that interface with the overall review of organic materials - protective coating systems as follows:

1. The ~~Equipment Qualification Branch~~ Plant Systems Branch (SPLB)[7] reviews the radiation and chemical environments of equipment under DBA conditions as part of its primary review responsibility for SRP Section 3.11.

2. The Containment Systems and Severe Accident Branch (SCSB)[8] reviews the control of combustible gases that can potentially be generated from the coating systems and organic materials and reviews the consequences of solid debris that can reach the containment recirculation sump as part of its primary review responsibility for SRP Sections 6.2.5 and 6.2.2, respectively.

3. The Reactor Systems Branch (SRXB)[9] as part of its primary review responsibility for SRP Sections 5.4.7 and 6.3 reviews the effects of solid debris on operations of fluid systems during post-accident conditions.

For those areas of review identified above as being reviewed as part of ~~the primary review responsibility of~~ other SRP Sections ~~branches~~, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section(s) ~~of the corresponding primary branch~~.[10]

II. ACCEPTANCE CRITERIA

~~CMEB~~ EMCB[11] acceptance criteria are based on meeting the relevant requirements of Appendix B to 10 CFR Part 50 as it relates to the quality assurance requirements for the design, fabrication and construction of safety-related structures, systems and components.

A coating system to be applied inside a containment is acceptable if it meets the regulatory positions of Regulatory Guide 1.54 and the standards of ~~ANSI N101.2~~ASTM D3842 and ASTM D3911[12] (References 4 and 5)[13].

Technical Rationale[14]

The technical rationale for application of the above acceptance criterion to protective coating systems is discussed in the following paragraph.

Appendix B to 10 CFR Part 50 requires a quality assurance program which comprises all those planned and systematic actions necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service. It is important to prevent the deterioration of protective coatings by one, all, or a combination of the following conditions: ionizing radiation, contamination by radioactive nuclides and subsequent decontamination processes, chemical and water sprays, high-temperature, high-pressure steam, and abrasion or wear. The protective coatings must be resistant to causing generation of combustible gases like hydrogen and methane and gaseous formation of radioactive organic iodides. If the protective coatings deteriorate by flaking, peeling, etc. they may form solid debris which can reach the containment recirculation sump and have a negative impact on the performance of post-accident cooling safety systems. Regulatory Guide 1.54 describes an acceptable method of complying with the quality assurance requirements in regard to protective coatings applied to ferritic steels, aluminum, stainless steel, zinc-coated (galvanized) steel, concrete, or masonry surfaces of nuclear facilities. Compliance with Appendix B to 10 CFR Part 50 is important to ensure the overall quality and safety performance of protective coatings under normal and accident conditions.

III. REVIEW PROCEDURES

The reviewer selects and emphasizes aspects of the areas covered by this review plan section as may be appropriate for a particular case. The judgment on the areas to be given attention and emphasis in the review is based on an inspection of the material presented to see whether or not it is similar to that recently reviewed on other plants and whether items of special safety significance are involved.

At the construction permit review stage, the reviewer verifies that the applicant has committed to using protective coating systems which meet the acceptance criteria.

At the operating license review stage, the reviewer determines the types and quantities of radiation and chemical decomposition products that can be produced from all the paints and organic materials which are exposed to the containment atmosphere. The paints and organic materials to be considered include those paints that are specified in the Safety Analysis Report (SAR), unspecified protective coatings on small machinery and equipment, and organic materials such as cable insulation. The determination is based on documented test data provided by the applicant. If test data are unavailable, a conservative analysis is required. The environmental conditions for the test and analysis must be comparable to those specified in Section 3.11 of the SAR. In the absence of test data on specific coating systems and organic materials, the data in Reference ~~3~~6[15] may be used to estimate the rates of hydrogen formation from zinc primers and from zinc primers plus topcoats. Cable insulation is assumed to generate hydrogen by radiolysis with a yield comparable to that of polyethylene (Reference ~~4~~7[16]). Unqualified paints (organic or inorganic), those that do not meet the acceptance criteria of this Standard Review Plan section, are assumed to form solid debris under DBA conditions. Unqualified paints that contain only organic materials and that do not meet the acceptance criteria of this Standard Review Plan section, are assumed to generate hydrogen by radiolytic decomposition with a yield comparable to that of organic polymers (Reference ~~4~~7[17]).

If combustible gases such as hydrogen and methane can be generated, the reviewer notifies the ~~Containment Systems Branch~~ SCSB[18] if this source is not included in Section 6.2.5 of the SAR. If a system to control combustible vapors is not provided, then the release of volatile alkanes to form organic iodides is of additional concern. The yield of organic iodides relative to the total iodine released after a DBA is estimated using the data of Reference ~~5~~3[19] and any applicable experimental results submitted by the applicant. The ~~Accident Evaluation Branch~~ Emergency Preparedness and Radiation Protection Branch (PERB)[20] should be notified of the estimated organic iodide formation.

If solid debris can be produced, the ~~Containment Systems Branch~~ SCSB[21] and ~~Reactor Systems Branch~~ SRXB[22] should be notified of the quantity of debris that can result from decomposition of unqualified materials. If the ~~Containment Systems Branch~~ SCSB[23] determines that the solid debris can reach the containment recirculation sump, the ~~Reactor Systems Branch~~ SRXB[24] determines the effects of the debris on the operation of post-accident fluid systems.

Any exception to Regulatory Guide 1.54 involving quality assurance and quality control requirements should be referred to the Quality Assurance and Maintenance Branch (HQMB)[25] for review and resolution.

Adverse interactions, if any, under DBA conditions, between the potential decomposition products, namely hydrogen and solid debris, and the engineered safety features are evaluated under SRP Sections 6.2.5 and 6.2.2, respectively.

For standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.[26]

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and the review and calculations support conclusions of the following types, to be included in the staff's safety evaluation report:

The staff concludes that the protective coating systems and their applications are acceptable and meet the requirements of Appendix B to 10 CFR Part 50. This conclusion is based on the applicant having met the quality assurance requirements of Appendix B to 10 CFR Part 50 since the coating systems and their applications meet the positions of Regulatory Guide 1.54, "Quality Assurance Requirements for Protective Coatings Applied to Water-Cooled Nuclear Power Plants" and the quality assurance standards of ~~ANSI N101.2, "Protective Coatings (Paints) for Light Water Nuclear Reactor Containment Facilities".~~ ASTM D3842, "Selection of Test Methods for Coatings for Use in Light-Water Nuclear Power Plants," and ASTM D3911, "Evaluating Coatings Used in Light-Water Nuclear Power Plants at Simulated Design Basis Accident (DBA) Conditions."[27] Also, the containment coating systems have been evaluated as to their suitability to withstand a postulated design basis accident (DBA) environment. The coating systems chosen by the applicant have been qualified under conditions which take into account the postulated DBA conditions.

For design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluation of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.[28]

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.[29] Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.[30]

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guide.

VI. REFERENCES

~~6.~~1.[31]10 CFR Part 50, Appendix B, Quality Assurance Criteria For Nuclear Power Plants and Fuel Reprocessing Plants.

~~1.~~2. Regulatory Guide 1.54, "Quality Assurance Requirements for Protective Coatings Applied to Water-Cooled Nuclear Power Plants."

~~2. ANSI N101.2, "Protective Coatings (Paints) for Light Water Nuclear Reactor Containment Facilities," American National Standards Institute (1972).~~[32]

~~5.~~3. A. K. Postma and R. W. Zavadoski, "Review of Organic Iodide Formation Under Accident Conditions in Water-Cooled Reactors," WASH-1233 (1972).

4. ASTM D3842 - 86 (Reapproved 1991), "Selection of Test Methods for Coatings for Use in Light-Water Nuclear Power Plants," American Society for Testing & Materials.[33]

5. ASTM D3911 - 89, "Evaluating Coatings Used in Light-Water Nuclear Power Plants at Simulated Design Basis Accident (DBA) Conditions," American Society for Testing & Materials.[34]

~~3.~~6. H. E. Zittel, "Post-Accident Hydrogen Generation from Protective Coatings in Power Reactors," Nuclear Technology, Volume 17, pp. 143-146 (1973).

~~4.~~7. R. O. Bolt and J. G. Carroll, "Radiation Effects on Organic Materials," Academic Press, New York (1963).

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SRP Draft Section 6.1.2
Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	SRP-UDP Format Item, Update PRB names.	Changed PRB name to reflect latest responsibility assignments for SRP Section 6.1.2.
2.	SRP-UDP format item, Reformat Areas of Review.	Revised review interface section of Areas of Review to be consistent with SRP-UDP required format that uses a number/paragraph format to distinguish how EMCB reviews aspects of protective coatings systems under other SRP sections and how other branches support the review of protective coating systems.
3.	SRP-UDP Format Item, Update PRB names.	Changed PRB name to reflect latest responsibility assignments for SRP section 6.5.2. This interface was relocated because the responsibility for SRP 6.5.2 has changed so it is now reviewed by the same PRB as SRP 6.1.2.
4.	Editorial.	Added due to change in PRB to the same PRB as for SRP 6.1.2.
5.	SRP-UDP Format Item, Update PRB names.	Changed PRB name to reflect latest responsibility assignments for SRP section 6.1.2.
6.	Editorial.	Added to correct grammar.
7.	SRP-UDP Format Item, Update PRB names.	Changed PRB name to reflect latest responsibility assignments for SRP section 3.11.
8.	SRP-UDP Format Item, Update PRB names.	Changed PRB name to reflect latest responsibility assignments for SRP sections 6.2.5 and 6.2.2.
9.	SRP-UDP Format Item, Update PRB names.	Changed PRB name to reflect latest responsibility assignments for SRP sections 5.4.7 and 6.3.
10.	Editorial and SRP-UDP Format Item	Simplified the text and accommodated the changes in the reformat of the Areas of Review, with interfaces to the SRP Section assigned to EMCB.
11.	SRP-UDP Format Item, Update PRB names.	Changed PRB name to reflect latest responsibility assignments for SRP section 6.1.2.
12.	**Integrated Impact #511**	The standards ASTM D3842 and ASTM D3911 were substituted for the ANSI N101.2 standard which has been withdrawn.
13.	SRP-UDP format item, reformat reference citations.	Added parenthetical reference identification for standards ASTM D3842 and ASTM D3911.
14.	SDR-UDP Format Item, Adding Technical Rationale	Technical Rationale was developed and added for 10 CFR Part 50Appendix B.
15.	SRP-UDP format item, Renumber references.	Reference number was revised due to placement of references in the proper group order.

Item	Source	Description
16.	SRP-UDP format item, Renumber references.	Reference number was revised due to placement of references in the proper group order.
17.	SRP-UDP format item, Renumber references.	References number was revised due to placement of references in the proper group order.
18.	SRP-UDP Format Item, Update PRB names.	Changed PRB name to reflect latest responsibility assignments for SRP section 6.2.5.
19.	SRP-UDP format item, Renumber references.	Reference number was revised due to placement of references in the proper group order.
20.	SRP-UDP Format Item, Update PRB Names.	Changed PRB name to reflect the responsibility for evaluation of offsite dose projections (e.g., in SRP 15.6.5.A).
21.	SRP-UDP Format Item, Update PRB names.	Changed PRB name to reflect latest responsibility assignments for SRP section 6.2.2.
22.	SRP-UDP Format Item, Update PRB names.	Changed PRB name to reflect latest responsibility assignments for SRP sections 5.4.7 and 6.3.
23.	SRP-UDP Format Item, Update PRB names.	Changed PRB name to reflect latest responsibility assignments for SRP section 6.2.2.
24.	SRP-UDP Format Item, Update PRB names.	Changed PRB name to reflect latest responsibility assignments for SRP sections 5.4.7 and 6.3.
25.	SRP-UDP Format Item, Update PRB names.	Changed PRB name to reflect latest responsibility assignments for SRP Chapter 17.
26.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
27.	**Integrated Impact #511**	The standards ASTM D3842 and ASTM D3911 were substituted for the ANSI N101.2 standard which has been withdrawn.
28.	10 CFR 52 applicability related change.	Added an evaluation finding paragraph to address design certification review findings. This finding paragraph is consistent with the SRP-UDP format for design certification evaluation findings.
29.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.
30.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
31.	SRP-UDP Format Item, Update Reference Order.	References were placed in the proper group order and reference numbers were revised accordingly.
32.	**Integrated Impact #511**	The Standards ASTM D3842 and ASTM 3911 were substituted for the ANSI N101.2 standard which has been withdrawn.

Item	Source	Description
33.	**Integrated Impact #511**	The standards ASTM D3842 and ASTM D3911 were substituted for the ANSI N101.2 standard which has been withdrawn.
34.	**Integrated Impact #511**	The standards ASTM D3842 and ASTM D3911 were substituted for the ANSI N101.2 standard which has been withdrawn.

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Integrated Impact No.	Issue	SRP Subsections Affected
511	Substitute ASTM D3842 - 86 and ASTM D3911 - 89 for citation of ANSI N101.2 (1972)	Subsection II: Acceptance Criteria (second paragraph) Subsection IV: Evaluation Findings (second paragraph) Subsection VI: References (Items 4 and 5)
746	Consider future work to revise standards citations in RG 1.54. (IPD 7.0 Form # 6.1.2-1)	No change to SRP